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the stresses usually experienced by these bones. The results show definitely that the strains put upon the bones by the muscles are not necessary to the growth of the bones. Such unstressed bones grew as much as 56% to nearly 100% in four and one-half months. On the other hand bones unstressed by muscles were much smaller in diameter, in the thickness of compacta, in the sizeof the trabeculae; were reduced in weight and in their resistance to crushing. Growth in length seems little influenced.

EPITHELIAL MOVEMENTS IN VITRO

Shinichi Matsumoto (Jour. Exp. Zool. Vol. 26, Aug. 1918) reports experiments in the culture of corneal epithelium of adult frogs *in vitro*. This is a favorable material because the transparency of the cornea is such as to allow direct observation of the cell movements. Various substrata were used—as flat surfaces of glass, celloidin, and dead cornea; spider web, silk fiber, glass wool, asbestos fiber; and porous bodies, such as thin pieces of pith.

The movements are amoeboid, with the cells tending to cling to their own kind and thus to form sheets. This is a most essential quality in forming and extending epithelial surfaces. The author believes this to be thigmotactic rather than chemotactic in nature, extending as they do over various types of surfaces. Rapid extension of epithelium may thus take place with no mitotic divisions at all.

The same author (Jour. Exp. Zool. Oct. 1918) discusses the technic and results of vital staining of these corneal cells in neutral red. When this was done by immersing the whole animal in a weak solution (1:100,000 to 1,000,000) the excised cells behaved in vitro just about as the unstained cells do, and were more readily followed because of the distinctness of the granules in the cytoplasm.

The corneal epithelium, incidentally, showed clear phagocytosis of the pigment of broken iris cells and of finely powdered granules of various stains.

ENTOMOLOGICAL ABSTRACTS

Physiology of Chironomus Larva.—In a study of the biology and physiology of the larva of *Chironomus gregarius*, Pause (1918, Zool. Jahrb., Abt.f. all. Zool. u. Physiol., 36:339-452) finds, among other things, that this larva has four molts. Tracheae, absent in the first instar, appear in the second, and are confined to the head and thorax.

They play no part in the process of respiration and are to be regarded as rudimentary organs. Exchange of gases is accomplished through the circulatory system A membrane, in the 11th and 12th segments, is so located that the blood stream is directed into the blood gills before it can return to the heart, thus making the latter strictly an "arterielles Herz." The haemoglobin which occurs in diffused form in the blood first appears in the second instar, its formation being coincident with the reversal of the distinct positive phototropic reaction of the young larva into a strong negative phototropic reaction. There is evidence that the amount and time of formation of the haemoglobin are not influenced by differences in nutrition or light reduction. The circulatory system supplies the tissues with oxygen, carries away the carbonic acid, and serves as a means of storing oxygen which can be utilized when the dissolved oxygen in the surrounding water becomes reduced. The larva of *Chironomus gregarius* requires some oxygen, but shows considerable resistance to oxygen reduction, this resistance increasing with the formation of haemoglobin. It succumbs to an oxygen content of 0.10 cc. per liter and it appears that 0.2 cc. per liter is very near the minimum quantity.

Wing Development in Aphids.—Shinji (1918, Biol. Bull., 35:95-116) reports that for a number of the common aphids certain chemicals in the soil in which food plants are grown—salts of the alkalis (Na, Cl K, etc.) and alkaline earths (Ca, Br,) constitute "non-wing-developing substances" while others (salts of the heavy metals, of magnesium, sugar, etc.) are "wing-developing substances." The former were only effective when applied within a certain period after birth, the period varying with the temperature and the species (in early summer—2-3 days in *Macrosiphum rosae*; 5-7 days in *Macrosiphum solanifoliae* and *Aphis brassicae*). A M/100 solution of magnesium sulphate operating for 12-24 hours produced nearly 100% winged individuals in *Macrosiphum rosae*. Aphids reared on twigs charged with non-wing-developing substances and subjected to sudden temperature changes of 100° F. to 35° F. failed to produce winged forms.

Sex Determination in Hymenoptera.—Whiting (1918, Biol. Bull., 34:250-256) finds that in *Hadrobracon brevicornis*, a parasitic wasp which deposits its eggs upon caterpillars of the Mediterranean flour moth, both bisexual and parthenogenetic reproduction occurs. Fertilized eggs produce *females* and unfertilized eggs produce *males.* Comparison with the honey bee leads to the supposition that the males are haplonts and the females diplonts.

Locomotion of Caterpillars.—Turner (1918, Biol. Bull., 34:137-148), in a series of experimental studies on surface feeding caterpillars, finds no evidence that their locomotions are tropisms. Such movements are "identical with those made by animals that learn by the trial and error method." Physiological unrest due to unusual environmental influences induce random movements which continue until stopped by fatigue or by attainment of more favorable environmental conditions.

Zoraptera.—Caudell (1918, Can. Ent., 50:375-381) describes a new species of Zoraptera (*Zorotypus hubbardi*) from ten specimens taken from termite galleries in Florida. The order Zoraptera was established by Silvestri in 1913 for three species of a single genus (Zorotypus): *guineensis* from Africa, *ceylonicus* from Ceylon, and *javanicus* from Java. He also described (1916) a new species (*Z. neotropicus*) from Costa Rica. The presence of this very primitive insect on the continent of North America is thus made known for the first time.

Immunity Principles in Insects.—Glaser (1918, Psyche, 25:39-46) finds that the value of the insect blood cells in ridding the body of foreign substances has been greatly exaggerated and that in reality they are usually rather passive. In grasshoppers and caterpillars, the blood cells do not seem to "phagocytose bacteria in an amaeboid fashion" and when bacteria occur in blood cells they may have entered of their own accord or have been included through some physical factor. However, blood seems able to overcome bacterial invasion to some extent due to elaborated substances which constitute extracellular antagonistic substances. Immunized grasshopper blood exhibits a marked degree of antagonism towards the bacteria used in producing immunity. The existence of an agglutinin in immune grasshopper blood was demonstrated.

Polyembryony in Insects.—Gatenby (1918, Quart. Journ. Micr. Sci., 63:175-196) presents a review of polyembryony as it occurs in the parasitic Hymenoptera, giving particular attention to the work of Marchal, Silvestri, Martin, and Patterson. Polyembryony—

the production of numerous embryos by a single egg—in insects is known at present in only two families of the parasitic Hymenoptera (Chalcididae and Proctotrypidae). Eggs of these parasites, fertilized or unfertilized, are deposited in the eggs of various insect hosts and develop in the subsequent larval stages of the latter. Polar bodies, given off by the parasite's egg, develop into a growing mass of nuclei, and the polar cytoplasm forms an investing sheath about the embryonic ooplasm, the latter ultimately producing the embryos. By repeated division, the primary embryonic cell gives rise to many germinal masses (polygerms) which continue to divide, ultimately resulting in numerous masses each containing an embryonic mass surrounded by two membranes. These final masses produce individual embryos, which later, as larvae, break away from their membranes and are free-living in the haemocoel of the host for a time, consuming the body tissues of the latter. Resulting broods may be exclusively male, exclusively female, or mixed, the latter probably resulting from two or more eggs, fertilized or unfertilized. As known at present, fertilized eggs produce females and unfertilized eggs, males. Gatenby claims that the "germ-cell determinant" is possibly a "nutrient cytoplasmic-mass" and does not later form the germ cells of each embryo; that there is no evidence of a germ-track and that "mere position in the morula is all that seems to determine whether this or that cell will be endoderm or ectoderm cell, etc." He also predicts the discovery of species which are polyembryonic or monoembryonic according to the season of the year, or according to some condition of the host egg or caterpillar.

Light and Muscle Tonus of Insects.—Garrey (1918, Journ. General Physiology, 1:101-125) has investigated the relationship between the tonus or tension of the skeletal muscles and the illumination of the eyes of heliotropic insects. Experiments were conducted mainly on the robber flies *Proctacanthus*, *Promachus*, and *Deromyia.* A number of butterflies (*Circionis alope*, *Vanessa huntera*, *Argynnis aphrodite*, et al), dragon flies, certain Vespidae, and representatives of several genera of Diptera were also used. The desired difference in illumination was obtained by coating the eyes wholly or in part with asphalt black varnish. When both eyes were blackened, inactivity, muscular weakness, and incoördination resulted. One eye blackened led, in most of the animals tried, to circus movements towards the side of the uncovered eye. Difference in illumination produced an asymmetry when the insect was at rest, and if it moved, it was forced toward the side of greater illumination. Tonus changes in the muscles were approximately proportional to the area of the eye blackened. Blackening the lower halves of the eyes caused the anterior end of body to be lifted far up from the horizontal support, head tilted back against thorax, and caudal end of abdomen pressed against the support. The exact opposite occurred on blackening the upper halves of the eyes. Blackening the upper half of one eye and the lower half of the other produced a combination of the effects just described. Symmetrical blackening of outer or inner halves of the eyes resulted in weakening of some groups of muscles but no asymmetry was produced. Insects which normally walk directly up a vertical surface or rest with the body axis in a vertical line, veered off at an angle towards the unblackened eye.

All heliotropic insects with one eye blackened ascended vertical cylinders obliquely. It thus appears that the muscle tonus of heliotropic insects is due chiefly to light. Each eye controls the tonus of a different group of muscles on both sides of the body and unequal photo-chemical reactions in the two eyes lead to asymmetrical conditions of muscle tension. The reactions vary directly with the intensity of the illumination. These experiments yield results which are in accord with Loeb's muscle tension theory of heliotropism.

Gynandry in Arachnida.—Hull (1918, Journ. Genetics, 7:171-181) divides arachnid gynandromorphs into three types: "1. One side male, the other female—sexual structures perfect except for a distortion resulting from the union of dissimilar halves on the median line." "2. As 1, but one side imperfectly developed before, the other behind," and "3. One side perfectly female before and male behind, the other perfectly male in front and female behind." So far as known at present gynandromorphs in Arachnida are confined to one order, Araneae.

Somatic Chromosomes in Coleoptera.—Hoy (1918, Biol. Bull., 35:166-169) finds that developing eggs and embryos of *Epilachna borealis* show eighteen chromosomes and have two kinds of chromatin content in somatic cells, an XY combination and an XX combination. Embryos of *Diabrotica vittata* contain two chromosome groups, one with twenty-one and the other with twenty-two, each type being constant in number and form in the various tissue cells studied.

Stoneflies and Plants.—Newcomer (1918, Journ. Agr. Research, 13:37-41), has studied the life history and habits of certain western stoneflies belonging to the genus Taeniopteryx. While adult Plecoptera are usually referred to as possessing the biting type of mouthparts, several American species have mouthparts which are more or less rudimentary. However, four species were found to possess well developed biting mouthparts and feed actively upon certain plants. *Taeniopteryx pacifica* was found to have the mandibles, maxillae, and labium completely developed and functional. While the foliage and buds of apricots, peaches, and plums are eaten, it is probable that such food habits are acquired. Of the native vegetation along streams, the foliage of the wild rose, wild cherry, alder, and elm and the leaves and catkins of willows are used as food. Two other species (*Taeniopteryx nigripennis* and *T. pallida*) feed actively upon thimbleberry, alder, willows, wildrose, serviceberry, and maple. Another species (*Taeniopteryx, sp.*) was observed feeding upon young cherry leaves.

Gynandromorphism.—Pettey (1918, South African Journ. Sci. 14:425-426) describes a case of right-left gynandromorphism in the moth *Metanastria pithyocampa* Cram. Sexual dimorphism in this species is exhibited by such characters as coloration, antennae, size, and pubescence, thus making a gynandromorph rather easily distinguishable. A male was found in connection with the gynandromorphic individual and in the copulatory position.

Oviposition of Notonectidae.—Hungerford (1918, Ent. News, 29:241-245), in a study of the oviposition habits of certain Notonectidae (*N. undulata; N. variabilis; N. insulata; N. irrorata*), finds that the first three mentioned have ovipositors poorly adapted for making incisions in plants of sufficient size to receive eggs and that while they are capable of abrading the surface of stems, only *N. irrorata* possesses an ovipositor capable of inserting the eggs in plant tissues. *N. irrorata* was observed to deposit eggs in the stems of moneywort, Juncus, and dead Typha, while the other species attach their eggs to the surface of stems. It is suggested that the structure of the ovipositors should be taken into account in determining the relationship of various species of Notonectidae.

Development of Flesh flies.—Kunkel (1918, Journ. Exp. Zool., 26:255-264) has tested the effects of mammalian thymus and thyroid on the development of flesh flies (*Lucilia caesar* and *Lucilia sericata*). When fed exclusively upon thyroid, growth of the larvae is slightly retarded; the resulting pupae are reduced in size, pupation is initiated earlier than normal and the period of pupation is shortened. Thymus tends to increase the size of the larvae. The results resemble those of similar experiments with vertebrates but are not so striking.

Terminology of Metamorphosis.—Comstock (1918, Ann. Ent. Soc. Am., 11:222-224) points out that in insects usually designated as having incomplete metamorphosis two distinct types of metamorphosis occur, one represented by such orders as Hemiptera and Orthoptera in which the development is direct, and the other represented by Plecoptera, Odonata, and Ephemerida in which there is cenogenetic development. The recognition of the distinct differences existing between the two groups of insects heretofore associated together gives support to a proposed revision of the following form: (1) *Gradual Metamorphosis* or paurometabolous development, characteristic of Orthoptera, Hemiptera, et al. (2) *Incomplete Metamorphosis* or hemimetabolous development, characteristic of Plecoptera, Odonata, and Ephemerida. (3) *Complete Metamorphosis* or homometabolous development, characteristic of Diptera, Lepidoptera, et al. Comstock proposes the restriction of the term *nymph* to the immature stages of *gradual metamorphosis*; the term *naiad* for the immature stages of Plecoptera, Odonata, and Ephemerida; and the term *larva* for the immature stages of all insects having complete metamorphosis.

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NOTES ON TECHNIQUE

(Abstracted by Dr. V. A. Latham)

A Mounting Medium.—The best mounting medium is liquid petrolatum. It has the proper consistency for mounts, is less sticky, does not become acid as is so common with the usual Canada balsam